

# HAZUS-MH: Earthquake Event Report

---

**Region Name:** GrandValley

**Earthquake Scenario:** GrandValley

**Print Date:** October 01, 2010

*Totals only reflect data for those census tracts/blocks included in the user's study region.*

**Disclaimer:**

*The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.*

## Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	6
Direct Earthquake Damage	7
Buildings Damage	
Critical Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	11
Fire Following Earthquake	
Debris Generation	
Social Impact	12
Shelter Requirements	
Casualties	
Economic Loss	13
Building Losses	
Transportation and Utility Lifeline Losses	
Long-term Indirect Economic Impacts	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value Data	

## General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 4 county(ies) from the following state(s):

Wyoming

Note:

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 5,948.78 square miles and contains 2,644 census tracts. There are over 6 thousand households in the region and has a total population of 16,607 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 10 thousand buildings in the region with a total building replacement value (excluding contents) of 1,218 (millions of dollars). Approximately 93.00 % of the buildings (and 77.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,235 and 8 (millions of dollars), respectively.

## Building and Lifeline Inventory

### **Building Inventory**

HAZUS estimates that there are 10 thousand buildings in the region which have an aggregate total replacement value of 1,218 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 73% of the building inventory. The remaining percentage is distributed between the other general building types.

### **Critical Facility Inventory**

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 15 beds. There are 13 schools, 8 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 23 dams identified within the region. Of these, 1 of the dams are classified as 'high hazard'. The inventory also includes 1 hazardous material sites, 0 military installations and 0 nuclear power plants.

### **Transportation and Utility Lifeline Inventory**

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 2,243.00 (millions of dollars). This inventory includes over 510 kilometers of highways, 91 bridges, 12,486 kilometers of pipes.

**Table 1: Transportation System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># locations/ # Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Highway</b>	Bridges	91	51.40
	Segments	42	2,030.10
	Tunnels	0	0.00
	Subtotal		<b>2,081.50</b>
<b>Railways</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	7	18.80
	Tunnels	0	0.00
	Subtotal		<b>18.80</b>
<b>Light Rail</b>	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
	Subtotal		<b>0.00</b>
<b>Bus</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Ferry</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Port</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Airport</b>	Facilities	2	21.30
	Runways	3	113.90
	Subtotal		<b>135.20</b>
		Total	<b>2,235.50</b>

**Table 2: Utility System Lifeline Inventory**

<b>System</b>	<b>Component</b>	<b># Locations / Segments</b>	<b>Replacement value (millions of dollars)</b>
<b>Potable Water</b>	Distribution Lines	NA	83.20
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		<b>83.20</b>
<b>Waste Water</b>	Distribution Lines	NA	83.20
	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		<b>83.20</b>
<b>Natural Gas</b>	Distribution Lines	NA	83.20
	Facilities	8	7.80
	Pipelines	0	0.00
	Subtotal		<b>91.10</b>
<b>Oil Systems</b>	Facilities	0	0.00
	Pipelines	0	0.00
	Subtotal		<b>0.00</b>
<b>Electrical Power</b>	Facilities	0	0.00
	Subtotal		<b>0.00</b>
<b>Communication</b>	Facilities	11	1.00
	Subtotal		<b>1.00</b>
		<b>Total</b>	<b>258.60</b>

## Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

<b>Scenario Name</b>	GrandValley
<b>Type of Earthquake</b>	User-defined
<b>Fault Name</b>	NA
<b>Historical Epicenter ID #</b>	NA
<b>Probabilistic Return Period</b>	NA
<b>Longitude of Epicenter</b>	NA
<b>Latitude of Epicenter</b>	NA
<b>Earthquake Magnitude</b>	7.10
<b>Depth (Km)</b>	NA
<b>Rupture Length (Km)</b>	NA
<b>Rupture Orientation (degrees)</b>	NA
<b>Attenuation Function</b>	NA

## Building Damage

### Building Damage

HAZUS estimates that about 3,779 buildings will be at least moderately damaged. This is over 35.00 % of the total number of buildings in the region. There are an estimated 584 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

**Table 3: Expected Building Damage by Occupancy**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Agriculture</b>	54	0.94	5	0.38	8	0.36	7	0.81	7	1.12
<b>Commercial</b>	202	3.53	21	1.58	54	2.33	75	8.56	48	8.21
<b>Education</b>	5	0.09	1	0.06	3	0.11	3	0.40	2	0.35
<b>Government</b>	10	0.18	1	0.07	2	0.09	4	0.42	2	0.35
<b>Industrial</b>	95	1.66	11	0.83	31	1.33	41	4.74	28	4.71
<b>Other Residential</b>	2,001	34.88	401	30.10	629	27.05	383	43.98	267	45.76
<b>Religion</b>	19	0.33	2	0.11	4	0.17	6	0.65	6	0.96
<b>Single Family</b>	3,351	58.40	890	66.87	1,593	68.56	352	40.43	225	38.54
<b>Total</b>	<b>5,738</b>		<b>1,331</b>		<b>2,324</b>		<b>871</b>		<b>584</b>	

**Table 4: Expected Building Damage by Building Type (All Design Levels)**

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
<b>Wood</b>	4,266	74.33	1143	85.83	1,973	84.89	320	36.76	256	43.90
<b>Steel</b>	149	2.60	13	0.99	24	1.03	57	6.51	51	8.68
<b>Concrete</b>	154	2.69	17	1.26	40	1.70	54	6.24	31	5.27
<b>Precast</b>	76	1.32	6	0.48	14	0.62	33	3.76	25	4.33
<b>RM</b>	393	6.86	31	2.33	107	4.59	159	18.20	66	11.34
<b>URM</b>	79	1.37	13	1.00	20	0.85	31	3.56	27	4.62
<b>MH</b>	621	10.82	108	8.10	147	6.32	217	24.96	128	21.85
<b>Total</b>	<b>5,738</b>		<b>1,331</b>		<b>2,324</b>		<b>871</b>		<b>584</b>	

\*Note:

RM      Reinforced Masonry  
URM     Unreinforced Masonry  
MH      Manufactured Housing



## **Essential Facility Damage**

Before the earthquake, the region had 15 hospital beds available for use. On the day of the earthquake, the model estimates that only 0 hospital beds (0.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 2.00% of the beds will be back in service. By 30 days, 21.00% will be operational.

**Table 5: Expected Damage to Essential Facilities**

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	1	0	0
Schools	13	6	0	7
EOCs	0	0	0	0
PoliceStations	5	2	0	3
FireStations	8	2	0	6

## Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

**Table 6: Expected Damage to the Transportation Systems**

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	42	0	0	42	42
	Bridges	91	8	4	83	83
	Tunnels	0	0	0	0	0
Railways	Segments	7	0	0	7	7
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	2	1	0	1	2
	Runways	3	0	0	3	3

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	0	0	0	0	0
Natural Gas	8	0	0	8	8
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	11	3	0	8	11

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	4,162	1484	450
Waste Water	4,162	1484	450
Natural Gas	4,162	1484	450
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	6,090	3,117	2,984	2,556	0	0
Electric Power		0	0	0	0	0

## Induced Earthquake Damage

### **Fire Following Earthquake**

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

### **Debris Generation**

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 102.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 32.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 4,080,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

## Social Impact

### **Shelter Requirement**

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 239 households to be displaced due to the earthquake. Of these, 150 people (out of a total population of 16,607) will seek temporary shelter in public shelters.

### **Casualties**

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
<b>2 AM</b>	Commercial	0	0	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	1	0	0	0
	Other-Residential	19	4	0	1
	Single Family	58	13	1	2
	<b>Total</b>	<b>78</b>	<b>18</b>	<b>2</b>	<b>3</b>
<b>2 PM</b>	Commercial	26	8	1	3
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	8	2	0	1
	Other-Residential	4	1	0	0
	Single Family	12	3	0	0
	<b>Total</b>	<b>50</b>	<b>14</b>	<b>2</b>	<b>4</b>
<b>5 PM</b>	Commercial	22	7	1	2
	Commuting	1	1	2	0
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	5	1	0	0
	Other-Residential	7	2	0	0
	Single Family	23	5	1	1
	<b>Total</b>	<b>58</b>	<b>16</b>	<b>4</b>	<b>4</b>

## Economic Loss

The total economic loss estimated for the earthquake is 283.93 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

### **Building-Related Losses**

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 239.91 (millions of dollars); 22 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 58 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

**Table 11: Building-Related Economic Loss Estimates**

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
<b>Income Losses</b>							
	Wage	0.00	1.62	7.06	0.48	0.65	9.82
	Capital-Related	0.00	0.70	6.30	0.32	0.27	7.59
	Rental	3.79	1.99	3.38	0.15	0.42	9.73
	Relocation	14.06	1.71	5.42	0.68	3.95	25.81
	<b>Subtotal</b>	<b>17.85</b>	<b>6.01</b>	<b>22.17</b>	<b>1.63</b>	<b>5.28</b>	<b>52.94</b>
<b>Capital Stock Losses</b>							
	Structural	17.53	2.70	6.89	2.54	3.92	33.59
	Non_Structural	65.44	10.05	18.78	8.71	11.06	114.04
	Content	16.94	2.00	8.25	5.40	5.01	37.59
	Inventory	0.00	0.00	0.32	1.32	0.11	1.74
	<b>Subtotal</b>	<b>99.90</b>	<b>14.75</b>	<b>34.24</b>	<b>17.98</b>	<b>20.10</b>	<b>186.97</b>
	<b>Total</b>	<b>117.75</b>	<b>20.77</b>	<b>56.41</b>	<b>19.60</b>	<b>25.38</b>	<b>239.91</b>

## Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

**Table 12: Transportation System Economic Losses**  
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	2,030.14	\$14.32	0.71
	Bridges	51.40	\$1.92	3.74
	Tunnels	0.00	\$0.00	0.00
	Subtotal	<b>2081.50</b>	<b>16.20</b>	
Railways	Segments	18.78	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>18.80</b>	<b>0.00</b>	
Light Rail	Segments	0.00	\$0.00	0.00
	Bridges	0.00	\$0.00	0.00
	Tunnels	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Bus	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Ferry	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Port	Facilities	0.00	\$0.00	0.00
	Subtotal	<b>0.00</b>	<b>0.00</b>	
Airport	Facilities	21.30	\$5.26	24.69
	Runways	113.89	\$0.00	0.00
	Subtotal	<b>135.20</b>	<b>5.30</b>	
	<b>Total</b>	<b>2235.50</b>	<b>21.50</b>	



**Table 13: Utility System Economic Losses**

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	83.20	\$7.47	8.97
	Subtotal	83.24	\$7.47	
Waste Water	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Distribution Lines	83.20	\$7.47	8.97
	Subtotal	83.24	\$7.47	
Natural Gas	Pipelines	0.00	\$0.00	0.00
	Facilities	7.80	\$0.03	0.40
	Distribution Lines	83.20	\$7.47	8.97
	Subtotal	91.09	\$7.50	
Oil Systems	Pipelines	0.00	\$0.00	0.00
	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Electrical Power	Facilities	0.00	\$0.00	0.00
	Subtotal	0.00	\$0.00	
Communication	Facilities	1.00	\$0.10	10.23
	Subtotal	0.99	\$0.10	
	Total	258.56	\$22.53	

**Table 14. Indirect Economic Impact with outside aid**  
(Employment as # of people and Income in millions of \$)

	LOSS	Total	%
<b>First Year</b>			
	Employment Impact	109	1.98
	Income Impact	70	0.09
<b>Second Year</b>			
	Employment Impact	28	0.51
	Income Impact	39	0.05
<b>Third Year</b>			
	Employment Impact	0	0.00
	Income Impact	6	0.01
<b>Fourth Year</b>			
	Employment Impact	0	0.00
	Income Impact	(6)	-0.01
<b>Fifth Year</b>			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.01
<b>Years 6 to 15</b>			
	Employment Impact	0	0.00
	Income Impact	(7)	-0.01

## **Appendix A: County Listing for the Region**

Lincoln,WY

Sublette,WY

Sweetwater,WY

Teton,WY

**Appendix B: Regional Population and Building Value Data**

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Wyoming	Lincoln	10,245	548	178	727
	Sublette	2,794	175	63	238
	Sweetwater	0	0	0	0
	Teton	3,568	218	34	253
Total State		16,607	941	275	1,218
Total Region		16,607	941	275	1,218